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US 4351007 A US 4249218 A

(58) Field of Search

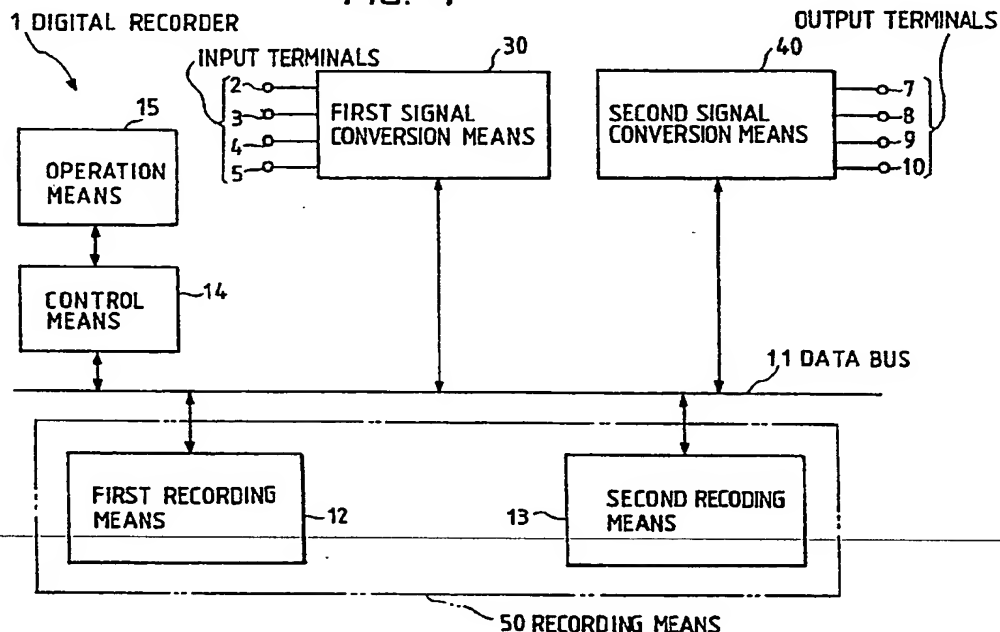
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(54) Digital recorder

(57) A digital recorder includes: an A/D converter 30, a D/A converter 40, a means 50 to record/reproduce a digital signal, an operation means 15 whereby the start and end edit points of a recording of the digital signal by the recording means 50 are instructed, and a control means 14 controlling 1) the recording of the signal for a short time prior to the recording start instruction, 2) the recording of the signal from the start of the recording to the end of the recording based on the start/end instructions, and 3) the recording of the signal for a short time after the end instruction of the recording. By this means it is possible to adjust an editing point to a desirable position even if the start and end points are not matched with the expected points. Recording prior to the recording start instruction may be in a first recording means 12, such as a semiconductor memory, whereas subsequent recording may be on a second recording means 13, e.g. magnetic discs.

FIG. 1



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FIG. 1

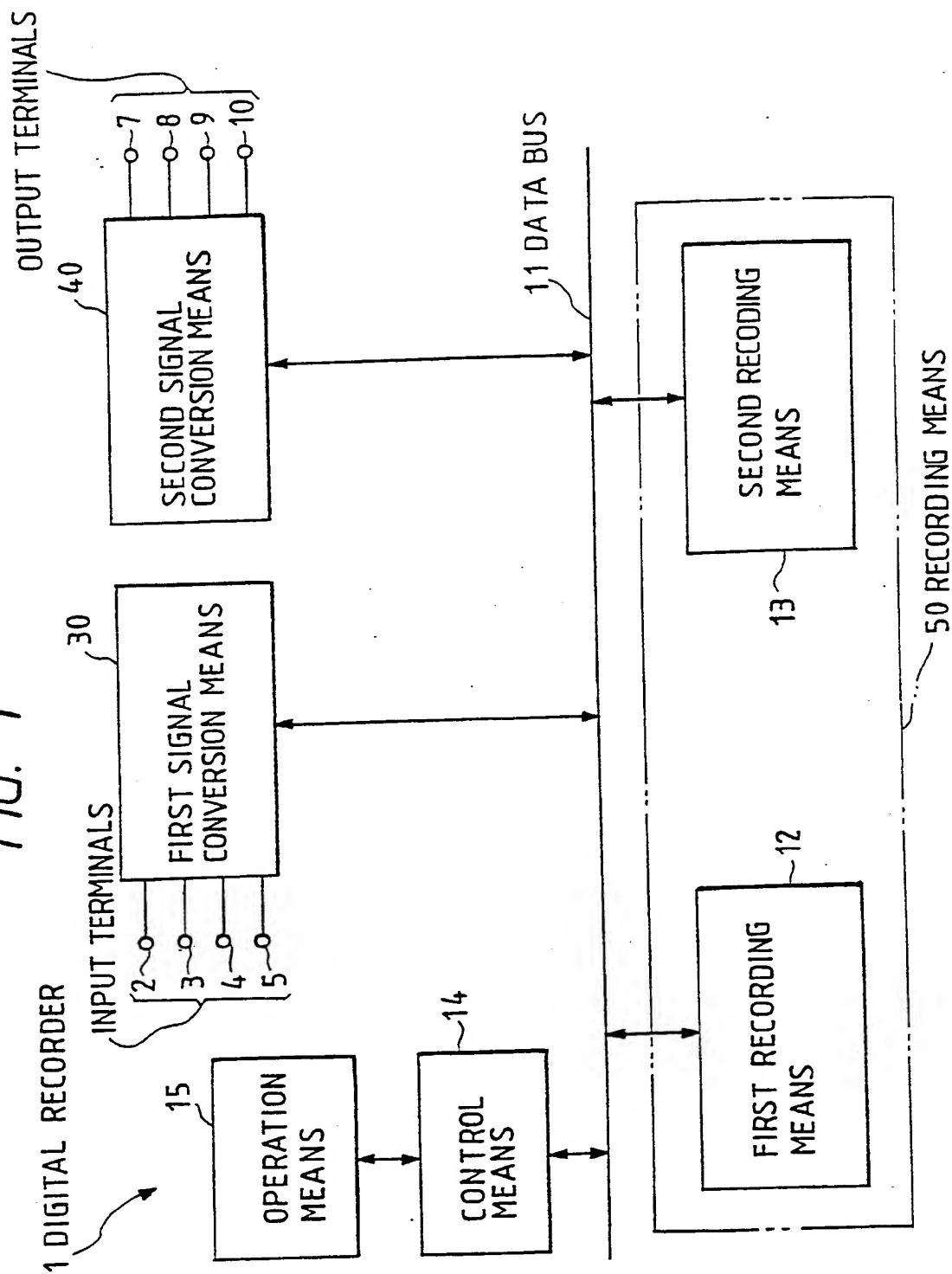


FIG. 2

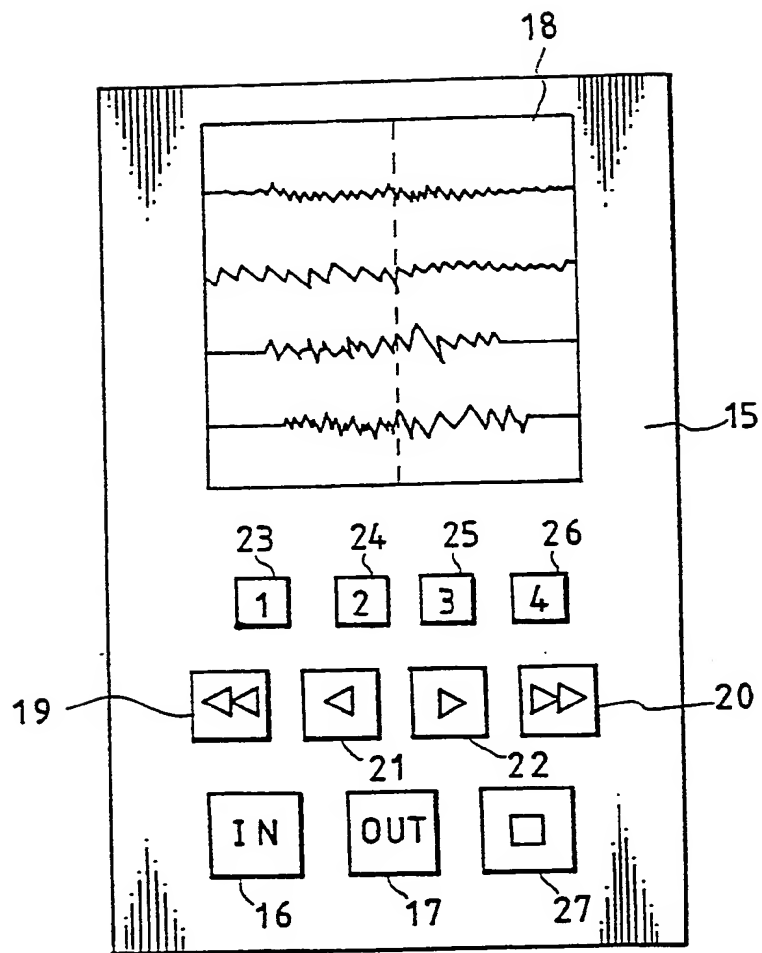


FIG. 3

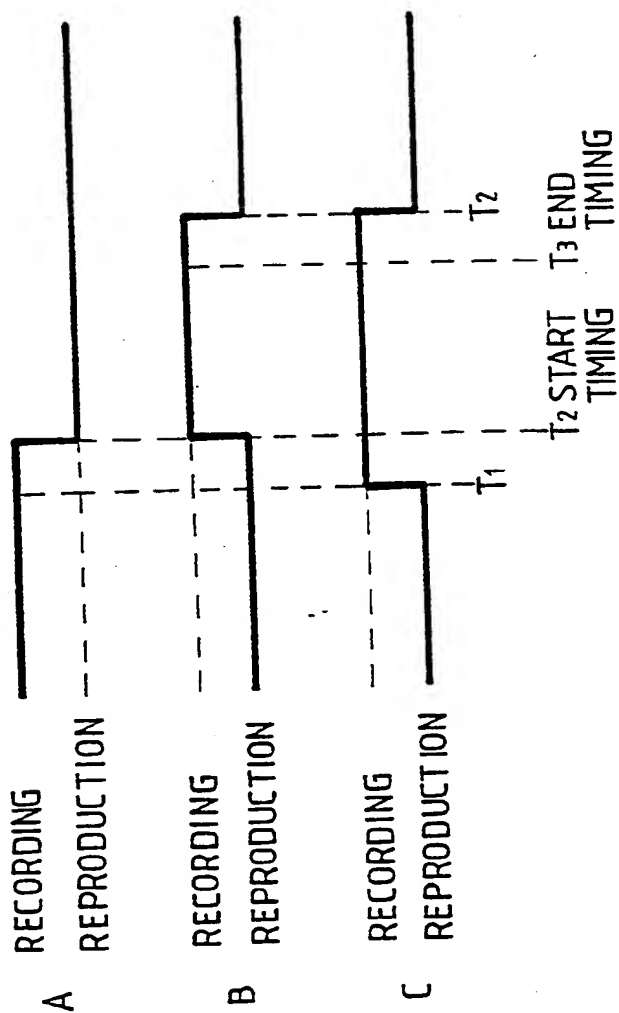
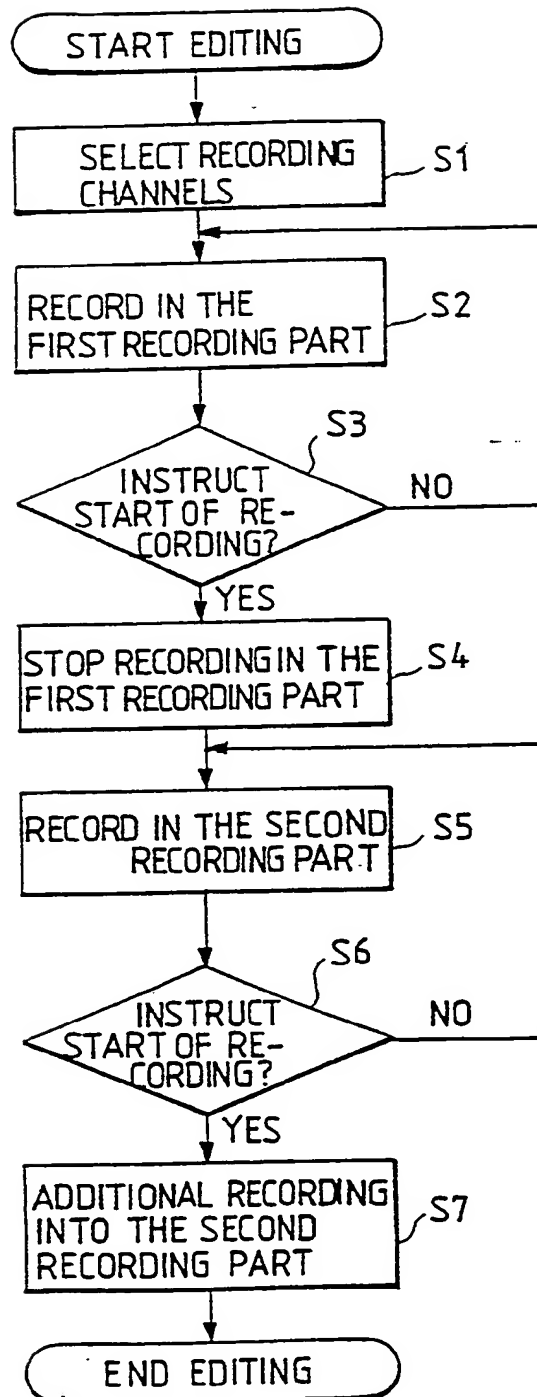


FIG. 4



## DIGITAL RECORDER

5       The present invention relates to a digital recorder which converts an audio signal or video signal into a digital signal and records the same, and more particularly, to a digital recorder which is suitable for editing an audio signal and a video signal.

10       A digital recorder utilizing a magnetic disk or a magnetic tape as a recording media performs recording and reproduction of a digital signal by converting an audio signal or a video signal into a digital signal. Since such digital recorder can easily handle the digital signal  
15       recorded in the recording media, it can be effectively used for editing the audio and video signals. For example, the digital recorder which is designed to deal with audio information and handles more than four audio channels simultaneously by using the magnetic disk as the recording  
20       media, is widely utilized for the same purpose as a conventional multi-channel analogue tape recorder. For instance, the digital recorder disclosed in the Japanese Patent Laying-Open No. 1-220284 has a recording means which records a digital signal proximate to an editing point. A  
25       semiconductor memory is utilized for this recording means in addition to the above-mentioned recording media. By utilizing the semiconductor memory, the reproduction of a signal can be done at higher speed than directly reproducing from the recording media. Further, the editing can be  
30       rehearsed on the semiconductor memory before performing the final edition on the record media such as a magnetic disk.

      Such digital recorder with the record means including the semiconductor memory for recording the digital signal near the editing point is very useful for editing the audio  
35       signals. Namely, a multi-channel digital recorder is

operated in order to edit the audio information in the same manner as the editing performed by the multi-channel analogue tape recorder. When certain audio information is substituted by another audio information in a channel which has been already recorded, for example, a starting point is set as A and an ending point as B. The editing operation between A and B is performed as follows. First, the digital recorder goes back to a point prior to the starting point A and sets to a reproduction mode. The audio information is sound monitored by an operator until it reaches the starting point A. When the audio information reaches the point A, the recording operation is performed thereafter. While listening the audio information continuously, if it reaches the ending point B, the recording is released. Namely, a timing of the recording operation (at the point A) and the record-releasing operation (at the point B) is determined manually based on the auditory sense of a person. Further, a start timing of the edition (recording) and an end timing of the edition (record-releasing) are designated by an elapse of time so that the operation of the digital recorder can be automatically controlled in terms of time by a control means. Such recording operation can realize a superior editing result so long as the newly recorded audio information is the one as expected and the timing between the point A and point B matches as expected. The digital recorder designed to edit the video information has the same structure as described above and can be realized by using the conventional technique.

However, there is a disadvantage in the conventional digital recorder when performing a partial substitution, i.e., in substituting a signal in a specific channel with another signal. That problem arises when the editing is manually proceeded as described in the foregoing, if the timings of the starting point and the end point of the editing operation fluctuate. As a result, the edition may be unsuccessful even if the renewed information itself is

obtained as planned. In reality, even though the contents of the renewed information is recorded as expected, the start and end points for edition often cannot be matched as expected. Therefore, in the conventional digital recorder, there is a disadvantage in that when the edition fails, the recorder has to go back to the starting point and proceed the editing operation again.

The present invention aims to solve the above-mentioned problem. An object of the present invention is to provide a digital recorder which is capable of shifting an editing point when editing the audio signal or the video signal in the digital recorder if the start point or the end point for the edition is not matched with the expected points.

In order to accomplish the above object, the digital recorder of the present invention comprising: a first signal conversion means outputting a digital signal converted from an input signal provided from outside, a second signal conversion means outputting an analogue signal converted from the digital signal to the outside, a recording means comprised of first and second recording parts enabling to record/reproduce the digital signal, an operation means instructing a start and end timing of the recording operation of the digital signal for the recording means, a control means for controlling the continuous recording based on the instructions from the operation means in recording prior to the start timing, during the start and the end timings, and after the end timing of the recording. More precisely, this control means controls the record timing of the digital signal in the first recording part prior to the start timing of the recording which is instructed by the operation means. When the instruction of the recording start timing is given, the control means stops the recording of the digital signal in the first recording part and continues the rest of the recording in the second recording part. When the instruction of the recording end timing is given, the digital signal is

still recorded in the second recording part for a predetermined period of time after the end timing. Then, the recording operation is terminated under the control of the control means.

5 As a result, the digital signal is recorded in the first recording part for a predetermined period of time before the recording start instruction. In addition, the remaining digital signal after the digital signal which is partially recorded in the first recording part is continuously recorded  
10 in the second recording part, and the digital signal is recorded therein for a predetermined period of time after the recording end instruction.

Thus, by means of the present invention, when partially substituting an original signal with a new signal for editing  
15 the audio and the video signals, it is possible to provide a digital recorder which is capable of adjusting the timing either in forward or in backward for substitution after the completion of the recording so long as the signal thus recorded is the one as expected.

An embodiment of the present invention will now be described with reference to the accompanying drawings, in which:-

Figure 1 is a block diagram showing a preferred embodiment of the present invention.

Figure 2 is a plan view showing an operation means of the preferred embodiment of the present invention.

25 Figure 3 is a timing chart showing an operation of the first and the second recording parts in the preferred embodiment of the present invention.

Figure 4 is a flow chart showing an operation of the first and the second recording parts in the preferred  
30 embodiment of the present invention.

In the following, a preferred embodiment of the present invention is described in detail.

35 Figure 1 shows a digital recorder 1 which is suitable for editing the audio signal for a multi-channel. In this preferred embodiment, by way of example, the digital

recorder 1 specifically has four channels handling four signals.

5       The digital recorder 1 includes: a first signal conversion means 30 for converging a signal from the outside and outputting it as a digital signal, a second signal conversion means 40 outputting a received signal to the outside as an analogue signal, a recording means 50 enabling to record/reproduce a digital signal, an operation means 15 instructing a start timing and an end timing of the recording for the digital signal for the recording means 50, a control means 14 which continuously controls: 1) the recording in the recording means 50 of the digital signal sent from the first signal conversion means 30 prior to the starting instruction given by the operation means 15, 2) the recording in the recording means 50 of the digital signal sent from the first signal conversion means 30 which is obtained during the start and end timing of the recording according to the start/end instruction given by the operation means 15, and 3) the recording in the recording means 50 of the digital signal sent from the first signal conversion means 30 after the completion of the recording. In addition, the digital recorder 1 includes a data bus 11 which transmits a control signal given to each elements and performs the recording/reproduction of the digital signal.

25       The first signal conversion means 30 includes input terminals 2, 3, 4 and 5 to which the analogue signals are supplied, wherein the analogue signals are converted to the digital signals and forwarded to the data bus 11.

30       The second signal conversion means 40 receives the digital signal from the data bus 11, converts the signal into the analogue signal, and outputs analogue signal to the outside through output terminals 7, 8, 9, and 10.

35       The recording means 50 includes the first recording part 12 and the second recording part 13 which are connected to the data bus 11. The first recording part 12 can be configured by a semiconductor memory because it only needs

300K byte per one channel in order to record the digital signal having 16 bit for three seconds, wherein the digital signal can be obtained, for example, by a sampling signal having a frequency of 48 KHz. The second recording part 13 can be configured by a plurality of magnetic disks connected in parallel in order to record the 16-bit digital signal obtained by a sampling signal having a frequency of 48 KHz for more than two hours for the four channels. Although the first recording part 12 and the second recording part 13 are separately described for memory management purpose as described in the following, it is not necessary that these memories are physically separated. Thus, it is also possible to provide the first and the second recording parts 12 and 13 on the same magnetic disk.

The control means 14 controls each element connected to the data bus 11 in a sequential manner as shown in Figure 4. The control means 14 includes an operation information judgment part for interpreting a signal from the operation means 15, a control signal output part for supplying the control signal to the recording means 50, and a time managing part for managing an address of a digital signal in a time domain.

The operation means 15 includes an operation part in order to perform each operation and provides operational information to the control means 14. As shown in Figure 2, the operation means 15 has a switch 16 for setting the recording start instruction, a switch 17 for setting the recording end instruction, editing position control keys 19 and 20, a record/reproduction direction control keys 21 and 22, recording channel selection keys 23, 24, 25 and 26 for selecting a recording channel out of the channels, and an operation stop key 27. The operation means 15 further includes a display 18 for displaying information such as an address of the digital signal in the time domain. This address is equivalent to a tape counter of an ordinary tape recorder. The editing position control keys 19 and 20 are

used in order to search a editing position. The record/reproduction direction control keys 21 and 22 are used in order to determine a direction for the recording and reproduction operation of the digital signal. The recording channel selection keys 23, 24, 25 and 26 are used to select a channel to be recorded. The operation stop key 27 is used to terminate the operation of the recorder.

Next, an operation of the digital recorder 1 will be described in the following in reference to Figures 3 and 4.

First, the start/end points for the edition is searched by the editing position control keys 19 and 20 and the record/reproduction direction control keys 21 and 22. Then, one of the channels for performing the edition is selected by the recording channel selection keys 23, 24, 25 and 26 (S1). The reproduction for the selected channel starts at a position prior to the start point. If reproduction position agrees with a start point to be edited during the reproduction process, the switch 16 is turned on. Later, if the reproduction position reaches an end point for the edition, the switch 17 is pressed.

In the above operation, a new digital signal has been recorded in the channel selected by the recording channel selection keys 23, 24, 25 and 26, which replaced the old digital signal in the channel.

Figure 3 is a schematic timing chart showing the operation of the first and the second recording parts 12 and 13 in performing the edition in the digital recorder 1 of Figure 1. The upper part A in Figure 3 shows the operation of the first recording part 12. The middle part B shows the operation of the second recording part 13. The lower part C shows the total operation of the first and second recording parts 12 and 13. A vertical axis designates operational modes (recording, reproduction) of the first and second recording parts 12 and 13, and a horizontal axis designates an elapse of time. An upper position indicates the recording mode and a lower position indicates the reproduction mode of

the first and the second recording parts 12 and 13 of the recording means 50.  $T_2$  shows the time when the operation means 15 is provided with the record start instruction.  $T_3$  shows the time when the operation means 15 is provided with the record end instruction. In the drawing, the part A indicates that the first recording part 12 maintains the recording mode until it reaches the time  $T_2$  and changes to the reproducing mode after that. The part B indicates that the second recording part 13 changes from the reproducing mode to the recording mode at the time  $T_2$  and returns to the reproducing mode again at the time  $T_4$ . The first recording part 12 is set to a ring memory structure during the recording mode by the time  $T_2$ . The ring memory is a memory which starts the recording from the first address to the last address, then after recording the last address, returns to the first address again for consecutively recording in the memory. Therefore, although the first recording part 12 maintains the recording mode until the time  $T_2$ , the digital signal which is actually recorded in the first recording part 12 is from  $T_1$  to  $T_2$ , where  $T_1$  comes prior to  $T_2$ . Further, the second recording part 13 keeps recording until it reaches the predetermined time  $T_4$ , even if the recording end instruction is given. The recording performed between  $T_3$  and  $T_4$  is a supplemental recording the time length of which is controlled by the control means 14. This additional time length controlled by the control means 14 can be equivalent to the recording time of the first recording part 12 such as three seconds. Therefore, by combining the first and second recording parts 12 and 13, the digital signal is recorded from  $T_1$  to  $T_4$ , including  $T_2$  and  $T_3$  therebetween.

The time information in  $T_1$ ,  $T_2$ ,  $T_3$  and  $T_4$  is recorded by hours, minutes, and seconds which are further subdivided. This time information is recorded by frame numbers in the recording media.  $T_2$  and  $T_3$  are determined by the time when the operation means 15 is operated.  $T_1$  and  $T_4$  are

automatically determined by the control means 14 after  $T_2$  and  $T_3$  are determined. The time information is managed by the control means 14 as additional information to the digital signal which is recorded in the first and second recording parts 12 and 13. In practice, a series of the time information may be added to the digital signal data and recorded in the first and second recording parts 12 and 13.

Next, the editing procedure of digital recorder of the present invention is described in detail in the following with reference to Figure 4.

After searching the start/end points for the edition by using the editing position control keys 19 and 20 and the record/reproduction direction control keys 21 and 22, one of the channels is selected by the recording channel selection keys 23, 24, 25 and 26 (S1). Then, the first recording part 12 is turned to the recording mode at the time  $T_1$ , and the digital signal outputted from the first signal conversion means 30 is recorded in the first recording part 12 from  $T_1$  to  $T_2$  (S2). The switch 16 of the operation means 15 is turned on and the recording is started at the time  $T_2$  (S3). The second recording part 13 is turned to the recording mode at the time  $T_2$  under the control of the control means 14, and the first recording part 12 is changed to the reproducing mode at the time  $T_2$  and is stopped the recording (S4). As a result, the latter part of the digital signal outputted from the first signal conversion means 30 is recorded in the second recording part 13 (S5). Next, when the switch 17 of the operation means 15 is turned on at the time  $T_3$  as the recording end instruction (S6), the digital signal is continuously recorded in the second recording part 13. Therefore, the digital signal is additionally recorded in the second recording part 13 during a certain period of time until the time  $T_4$  (S7). The second recording part 13 is changed to the reproduction mode at the time  $T_4$ .

As in the foregoing, since the digital signal is additionally recorded in the first recording part 12 prior to

the record starting point and also in the second recording part 13 after the recording end point, it is possible to adjust the timing after the completion of the recording, even if the timings of the start and the end for the recording are varied and not matched with the expected timing. Namely, in a typical editing process, the timing of the start and end of the recording is relatively accurate and may not need a correction. However, by means of the present preferred embodiment, even if the timing of the start and end of the recording is fluctuated, it is possible to adjust the timing forwardly/backwardly after the completion of the recording. Therefore, the necessity of remaking the recording procedure for the editing is largely reduced.

Further to the foregoing embodiments, the present invention further enables various types of modifications within a scope of the present invention.

For instance, although the preferred embodiment in Figure 1 shows an example which performs the additional recording after the completion of the recording, the recording time for adding the information can be minimized to zero according to circumstances. The first and second recording parts can be structured any recording such as a semiconductor memory, a magnetic disk or the like and which part of these media should be used as the first or the second recording parts can be defined by the control means. Further, if the first recording part is constructed by the semiconductor memory and the second recording part is constructed by the magnetic disk, and if the digital signal recorded in the first recording part is transferred to the magnetic disk along with the second recording part after the recording of the substituted digital signal is completed, the semiconductor memory can be reused for other editing procedures.

In the foregoing, the preferred embodiment shows the editing of the audio signals. However, the present invention

is applicable with the similar structure to the digital recorder for editing the video signal.

CLAIMS:

1. A digital recorder comprising:

a first signal conversion means outputting a digital signal converted from an input signal provided from the outside,

a second signal conversion means outputting an analogue signal converted from said digital signal to the outside,

a recording means enabling to record/read-out said digital signal,

an operation means instructing a start/end timing of a recording operation of said digital signal for said recording means,

a control means continuously controlling said recording means in which:

said digital signal provided from said first signal conversion means is recorded prior to a start timing of which an instruction is given by said operation means,

said digital signal provided from said first signal conversion means is recorded during said start and said end timings based on said recording start/end instructions given by said operation means,

said digital signal provided from said first signal conversion means is recorded after said end timing of said recording.

2. A digital recorder as defined in Claim 1, wherein said recording means includes first and second recording parts, said control means controls said recording of said digital signal in said recording means before said recording start instruction is given by said operation means and interrupts said recording of said digital signal in said first recording part, said control means further controls a continuation of said recording of a remaining of said digital signal in said second recording part.

3. A digital recorder as defined in Claim 1, wherein:  
said recording means includes first and  
second recording parts,

5        said control means controls said recording of  
said digital signal in said recording means prior  
to said recording start instruction given by said  
operation means, interrupts said recording of said  
digital signal in said first recording part, and  
continues to record said remaining of said digital  
in said second recording part,

10        after said recording end instruction is  
given, said digital signal is continuously  
recorded in said second recording part for a  
predetermined period of time and said recording  
operation in said second recording part is  
15        eventually completed by said control means.

4. A digital recorder substantially as herein  
described with reference to and/or as shown in  
the accompanying drawings.



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